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FOLEY AND LARDNER LLP SUITE 500 3000 K STREET NW WASHINGTON, DC 20007			EXAMINER RUGGLES, JOHN S	
			ART UNIT 1756	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/689,547	Applicant(s) CROCKER ET AL.	
	Examiner John Ruggles	Art Unit 1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 July 2007.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3,7-13,17-23,25,29-41,44-47,66-72 and 98-101 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-3,7-13,17-23,25,29-41,44-47,66-72 and 98-101 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 July 2007 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination (RCE) under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicants' submission filed on 7/16/07 has been entered.

Response to Amendment

In the current 7/16/07 RCE amendment submission, the status of each claim is as follows:

claims 1, 40, 47, 66, and 101 are *currently amended*,

claims 2-3, 7-13, 17-23, 25, 29-36, 41, 44-46, and 67-72 remain as *original*,

claims 4-6, 14-16, 24, 26-28, 42-43, 48-65, and 73-97 are now **canceled**, and

claims 37-39 and 98-100 remain as *previously presented*.

Therefore, only claims 1-3, 7-13, 17-23, 25, 29-41, 44-47, 66-72, and 98-101 remain under consideration as currently amended and as further limited by the previously elected specie (2) drawn to only methods of repairing or making phase shift masks (PSMs) for radiation lithography.

The previous objections to the drawings numbered (v)-(viii) are withdrawn in view of (a) the current specification amendment at page 15 line 24 now referring to Figures 3A and 3B together and (b) the current replacement sheets for Figures 19 and 21.

The previous specifically exemplified objections to the specification numbered (4)(a)-(b), (5), and (6)(a)-(b) are each withdrawn in view of current specification amendments. However, further examples of objections to the specification are listed below.

The previous rejection of claim 6 under the second paragraph of 35 U.S.C. 112 is withdrawn in view of the current amendment in which this claim is now cancelled.

The previous art rejections are re-written below under 35 U.S.C. 103(a) as necessitated by Applicants' current amendment and accompanying remarks, to which responses are provided below.

Specification

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms, which are not clear, concise and exact. The specification should again be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some remaining unclear, inexact or verbose terms used in the specification are: (7) on page 7 in the 2nd full paragraph at line 1, "enhance" should be corrected to ~~--enhance~~ enhanced--; (8) in the paragraph bridging pages 7-8 at lines 1-2, "with e.g. with" is repetitive and should be changed to ~~--with e.g. with~~ with, e.g.,--; (9) (a) on page 22 at line 1, the section heading for Example 4 has been misspelled due to missing letters in the words of this heading that must be corrected appropriately; and similar misspellings due to missing letters also exist at least (b) on page 23 in the Part 3: section heading, (c) on page 29 in the Part 6: section heading, and (d) on page 32 in the Part 7: section heading. Note that due to the number of errors, those listed here are merely examples of the corrections needed and do not represent an exhaustive list thereof.

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Appropriate correction is still required. An amendment filed making all appropriate corrections must be accompanied by a statement that the amendment contains no new matter and also by a brief description specifically pointing out which portion of the original specification provides support for each of these corrections.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-3, 7-13, 17-23, 25, 29-34, 36-41, 44-47, 66-72, and 98-101 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946), either Park et al. (US 5,871,869) or Starodubov (US 5,972,542), and further in view of Ukrainczyk (US 6,253,015) and Mancevski (US 6,146,227).

Lewis et al. teach a process of repairing a mask by delivering liquid or gas through a cantilevered hollow micropipette attached to an atomic force microscope (AFM) tip or probe head, allowing nanometric spatial control of specifically localized chrome etching to be demonstrated without detectable effects on the underlying glass substrate of the mask (abstract, *instant claims 2, 36-39, 41, 46*). For the micropipette, a quartz nanopipette can have an outer diameter at the tip of 10nm and a hole in the middle that can be as small as 3nm (p2689/left col., which is clearly capable of repairing defects that are of similar or larger size, reading on *instant claims 9-13*). A reflective metal layer on the backside is used to detect bending movement of the

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AFM cantilever (Figure 1, p2689/right col.). The width of etched lines includes specific examples at 100nm and 1,150nm, with the depth exemplified by 120nm and 200nm, respectively (p2691/left col., *instant claims 20-23, 66-71*). Contemplated variations specifically include the use of intermittent contact-mode AFM delivery similar to that achieved by an ink jet printer, controlled distribution or confinement of liquid between the pipette or hollow tip and the substrate treated by altering the geometry or the surface of the hollow pipette tip to be either hydrophobic or hydrophilic, or alternative equipping of the pipette or hollow tip of an AFM to apply an electrical voltage or illumination on the surface treated to further improve resolution of the pattern formed or repaired (e.g., on the mask, etc.). This technology has wide implications both for the use of this methodology in controlled nanochemistry with liquids or reactive gases (p2691/right col.). For the purpose of this rejection, the contact-mode AFM delivery similar to that achieved by an ink jet printer (which is very well known for selectively depositing ink as coating material) is interpreted as being inherently capable of additive patterning by using a coated AFM tip to deliver coating material for selectively making or repairing a patterned mask. Also in this rejection, the controlled distribution or confinement of liquid between the hollow tip and the substrate treated by altering the geometry or the surface of the hollow tip to be either hydrophobic or hydrophilic is understood to facilitate transfer of liquid such as coating material from the tip to the surface treated (e.g., to repair a nanometer scale missing part or clear defect on a patterned mask by depositing an opaque material such as Cr [noting that it is well known in the metal coating art that a metal coating can be derived from post-treatment of a deposited precursor material or compound containing such metal], etc., *instant claims 7-8, 18, 25, 30, 34, 44*). This further suggests the suitability of an AFM having a tip coated with material for

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delivery to a desired substrate to effect additive repair of a patterned mask and/or a desired etchant for subtractive repair of a patterned mask, without requiring any voltage bias between the AFM tip and the desired substrate or the mask, and also without requiring any vacuum conditions during such treatment of the desired substrate or the mask (*instant claims 31, 98-101*).

The teachings of Lewis et al. discussed above that include the finely controlled selective delivery of liquid material from an AFM having a hollow tip coated with the liquid material onto a defective patterned mask for repair of defects on the mask is interpreted in this rejection to primarily focus on subtractive repair of defective patterned masks by etching to remove excess defects (e.g., to remove excess opaque Cr defects from a patterned mask, etc.). Even though alternatively contemplating the potential suitability of using an AFM tip to selectively deposit material for additive repair of a defective patterned mask (as discussed above), Lewis et al. do not teach specific examples or any detailed description of such additive repair for patterned masks. Also, Lewis et al. do not specifically teach using a sol-gel coating material (*instant claims 1, 40, 47*) for additive patterning or repairing of a mask, such as a PSM.

Miller teaches a process of patterning and/or building up layered nanoscale features on a substrate by selectively applying first and second materials with a nanoscale delivery device. A first difunctional molecule is applied and reacted with a surface of the substrate and a second difunctional molecule is applied and reacted with previously unreacted functional groups from the first difunctional molecule to form a patterned layer on the surface of the substrate (title, abstract). The difunctional molecule may be any that is known to those skilled in the art, such as a difunctional monomer, oligomer, or polymer. The number of repeating units in the backbone of the molecule can range from one to thousands (1 to 1,000s, which clearly reads on high

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molecular weight compounds, *instant claim 29*), depending on the final application and intended use (c2/L39-48). Any known substrate material can be used; particularly materials such as glass, metal (Au), silicon (Si), polymers, or germanium (Ge) are given as examples of suitable substrate materials (c2/L59-67). Any device known to those skilled in the art may serve as the nanoscale delivery device. Figure 2 shows the device 40, in general, comprising a probe 50 having a microfluidic device 60 attached thereto. One type of probe used is a proximal probe from an atomic force microscope (AFM). The microfluidic device forces or encourages the flow of the molecule to be applied to the surface of a substrate or another molecule. The probe may be chemically treated to induce transfer. Alternatively or in addition to the chemical treatment, a carbon nanotube may be incorporated into the probe tip. These nanotubes function similarly to that of a (hollow) fountain pen, making it possible to transfer the difunctional molecule to the substrate or to direct placement of the difunctional molecule with respect to a previously reacted difunctional molecule. The nanoscale delivery device allows formation of an ultra small pattern for further processing into such devices as semiconductors or electronic devices in a cost effective, well-controlled manner (c3/L31-53). Reaction of the first and second difunctional molecules at functional groups can be enhanced by exposure to a radiation source, such as a scanning electron beam, x-rays, ultraviolet (UV) or visible light, or a thermal energy source (c2/L54-65). The radiation energy source can be extended from a nanoscale delivery device, as previously described (c3/L33-34). AFM probes have been previously known to transfer a very small amount of chemical material onto a surface to form a very small feature (tens of nm in dimension, c1/L36-40). As exemplified in step 6 of Figure 1, many multiple layers of either the same or different materials can be built up on a common substrate to form nanoscale features of

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the desired coating materials and total thickness, which are determined by the final application for the multilayered product (c4/L56 to c5/L9, *instant claims 19, 32-33, 45, 72*).

Park et al. teach a method of manufacturing a PSM that includes patterning a PS layer (title, abstract). This PSM is usable for forming fine patterns in a semiconductor device (c1/L5-11). Figure 2 shows an example of a PSM having a (transparent) PS layer of a metal oxide (e.g., TiO_2 , ZrO_2 , CrO_2 , ZnO_2 , etc., *instant claim 25*) coated by a sol-gel method to yield a refractive index of about 1.6 to 2.3 on a transparent substrate (e.g., of soda lime glass, quartz, etc.). The thickness of the PS layer (e.g., about 140nm to 310nm, etc.) formed from the sol-gel is determined from equation 1 based on the incident exposure wavelength (e.g., 365nm, etc.) and the refractive index of the PS layer, in order to shift the phase of the incident light by 180° (c3/L15-39, c4/L6-8).

Starodubov teaches a sol-gel process of applying silica sol onto a substrate and molding the sol to form a (transparent) solid glass layer having a desired structure/pattern for a PSM, or even for a reflective PSM having an additional reflective layer (c4/L41-56). Also see claims 8-9 for a sol-gel process to form a silica glass structure on a mask substrate (of a PSM, c11/L19-22, *instant claim 25*).

Ukrainczyk teaches that a glass layer 14 (waveguide core, which can be any suitable glass that is transparent to the desired wavelength) is preferably deposited by known sol-gel technique(s), because such technique(s) produce smoother surfaces with fewer defects (that could otherwise cause surface scattering of light at the interfaces between layers, e.g., between the core and a cladding, etc.), and the sol-gel coating can be selectively deposited on the

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substrate (undercladding) layer 12 (of e.g., high-silica glass, other glass, etc.) through opening(s) in a coating mask (c7/L38 to c8/L5).

Mancevski teaches the use of an AFM cantilever with a carbon nanotube tip for mask repair or possibly as a lithography tool (c4/L9-11). It is known to those skilled in the art that sol-gel deposition can be used to coat the inside of a template or porous membrane substrate (e.g., with semiconductor or catalyst material, etc.) by dipping it into a sol-gel solution, then the membrane substrate is removed from the sol-gel solution and dried (e.g., to form a coated hollow tip on the AFM cantilever, etc.). The form of the resulting coating on the substrate depends on the temperature of the sol-gel solution and the time of contact between the sol-gel solution and the substrate. This sol-gel method can be used to deposit metal catalysts, such as Ni, Fe, or Co catalyst, instead of semiconductor materials (c8/L63 to c9/L7, c9/L13-14). Thus, it is feasible to dip sol-gel solution coating material or sol-gel catalyst (precursor, *instant claim 25*) material into or on the hollow tip of an AFM (e.g., without clogging the hollow tip, etc.). One of ordinary skill would further have recognized that the sol-gel solution coating material or the sol-gel precursor material could also be transported with fine control (before it is dried) by the AFM hollow tip to a desired region of the mask for additive repair of the mask.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the subtractive patterned mask repair process using an AFM having a hollow liquid coated tip with extremely fine control over the removal of excess opaque material defects (as taught by Lewis et al.) to alternatively or even additionally extend the use of the extremely finely controlled AFM tip for additive repair of the patterned mask by distributing desired coating material from the AFM tip (that may be chemically treated to induce transfer) onto a substrate of

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any suitable known material (e.g., glass, metal, etc.), including building up plural layers of this coating material (as taught by Miller). This is because at least the glass and metal substrate materials considered suitable for coating and even building up plural layers of coating material (taught by Miller) would be compatible with patterning or repairing a finely patterned mask having a metal pattern on a glass substrate (as taught by Lewis et al.), which provides a reasonable expectation of success for additive repair of a clear deficiency defect in an opaque pattern on a finely patterned mask by using the finely controlled AFM having a liquid coated tip. This AFM having a liquid coated tip would also function as a nanoscale delivery device to allow formation of an ultra small patterned feature (tens of nm in dimension) in a cost effective, well-controlled manner (as taught by Miller). Furthermore, this AFM having a liquid coated tip would also be suitable for extremely finely controlled selective coating and/or selective etching of electrically non-conductive substrates as well as conductive substrates, including multilayer structures of diverse materials (e.g., to repair a defective mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc.), because an AFM probe tip can be used with conductive and/or non-conductive substrates. It would also have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using a SPM probe tip, such as a hollow tip AFM probe (taught by Lewis et al. and Miller) that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Park et al. or Starodubov, *instant claims 3, 17*), because: (a) sol-gel coating methods are known to produce smoother surfaces with fewer defects (e.g., for coating transparent glass material on an optical substrate, etc., as taught by Ukrainczyk); (b) it is feasible

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to dip sol-gel solution coating material or sol-gel catalyst (precursor) material into or on the hollow tip of an AFM (e.g., without clogging the hollow tip, etc.) to be used for repairing a mask (as taught by Mancevski, e.g., for additive repair of the mask, etc.). This would provide a reasonable expectation of success for producing or repairing transparent PS material on a PSM by extremely finely controlled addition of sol-gel coating or precursor material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair a mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claims 1, 40, 47*).

Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946), either Park et al. (US 5,871,869) or Starodubov (US 5,972,542), further in view of Ukrainczyk (US 6,253,015) and Mancevski (US 6,146,227) as applied above to claims 1-3, 7-13, 17-23, 25, 29-34, 36-41, 44-47, 66-72, and 98-101, and further in view of Kley (US 6,337,479).

While teaching most aspects of the instant claim, Lewis et al., Miller, either Park et al. or Starodubov, Ukrainczyk, and Mancevski do not specifically teach the use of plural tips on the AFM for repairing the mask (such as a PSM).

Kley teaches SPM inspection and/or modification of an object (title, abstract), in which the object is specifically exemplified as being a semiconductor fabrication mask that is modified or repaired and the desired resolution for the repair of the mask is on the order of a single molecule (1 Angstrom (0.1nm) or LESS, c1/L65-67). An electron beam from the SPM tip can be used to chemically break up material including polymers or to stimulate other chemical

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reactions (c53/L40-63). The SPM can be an AFM probe or a SEM probe (c54/L1). Figure 2 specifically shows an exemplary SPM or AFM probe 122-1 having plural cantilevers 136, each cantilever having a corresponding tip 138 (e.g., for precision control of plural subtractive and/or additive repair operations on a defective mask, etc., c7/L41-46,61-62, c7/L64 to c8/L7, c9/L41-47, c10/L23-24,30-37, *instant claim 35*).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using an SPM probe, such as a hollow tip AFM probe that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Lewis et al., Miller, either Park et al. or Starodubov, Ukrainczyk, and Mancevski) to use plural probe tips for modifying or repairing the mask (as taught by Kley), because this would provide a reasonable expectation of success for precision control of plural additive and/or subtractive repair operations on the mask (as taught by Kley), while obtaining the benefit of reduced processing time during the mask repair. This would also provide for extremely finely controlled addition of sol-gel coating material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair transparent PS material on a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claim 35*).

Claims 1-3, 7-13, 17-23, 25, 29-34, 36-41, 44-47, 66-72, and 98-101 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946), either Park et al. (US 5,871,869) or Starodubov (US 5,972,542), further

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in view of Ukrainczyk (US 6,253,015) and Mancevski (US 6,146,227), and further in view of either Mirkin et al. '62004 (US 2003/0162004) or Mirkin et al. '42106 (US 2004/0142106).

Even though alternatively contemplating the potential suitability of using an AFM tip to selectively deposit material for additive repair of a defective patterned mask (as discussed above), Lewis et al. do not teach specific examples or any detailed description of such additive repair for patterned masks. Also, Lewis et al. do not specifically teach using a sol-gel coating material (*instant claims 1, 40, 47*) for additive patterning or repairing of a mask, such as a PSM.

The teachings of Miller, Park et al., Starodubov, Ukrainczyk, and Mancevski are discussed above. In addition to the basis for additive repair of a mask using a sol-gel coating material as set forth above, further motivation for this combination is provided by either of the following additional references.

Mirkin et al. '62004 teach direct-write nanolithography from the surface of a scanning probe microscope (SPM) tip (e.g., an AFM tip, etc., as shown in Figure 1) having patterning compound thereon for contacting with a substrate to cause selective coating on the substrate (title, abstract). This direct-write nanolithography is also referred to as dip pen nanolithography (DPN), which allows ultrahigh resolution for mask fabrication using a wide variety of functional groups at a relatively low cost (abstract, [0019]). DPN selective printing (e.g., for high resolution masks, etc.) using sol-gel chemistry (coating material) provides a low temperature (which may be close to room temperature [0048]) method using precursors to produce a wide range of compositions (e.g., glasses, metal oxides, ceramics, etc.) in various forms with better purity and homogeneity than would be achieved with high temperature conventional processes [0043]. A metal oxide precursor inking composition can be placed on a tip (of an AFM probe)

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and transferred for selectively coating a desired substrate, which is then subsequently processed as needed [0049] (which may include heating to substantially complete the sol-gel process [0073]).

Mirkin et al. '42106 teach a direct write coating method by a conventional AFM tip using a sol-gel process for coating a magnetic material precursor solution in a pattern that can be post-treated at elevated temperature to generate magnetic features to form feature sizes ranging from several hundred nm down to 100nm or LESS, allowing deliberate control over feature size and shape, as well as interfeature distance and location (title, abstract). Other advantages include the use of relatively inexpensive instrumentation, good alignment and resolution, and versatility in compositions that can be deposited under controlled conditions [0018]. AFM tips are particularly preferred and the depositing or coating step can be carried out by using a hollow tip, wherein the patterning ink is transported through the hollow aspect of the tip. Also, the depositing step can be carried out with use of a sol-gel precursor [0055], which implies using the AFM hollow tip to transport the sol-gel precursor for selective coating of the sol-gel precursor onto the desired substrate.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the subtractive patterned mask repair process using an AFM having a hollow liquid coated tip with extremely fine control over the removal of excess opaque material defects (as taught by Lewis et al.) to alternatively or even additionally extend the use of the extremely finely controlled AFM tip for additive repair of the patterned mask by distributing desired coating material from the AFM tip (that may be chemically treated to induce transfer) onto a substrate of any suitable known material (e.g., glass, metal, etc.), including building up plural layers of this

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coating material (as taught by Miller). This is because at least the glass and metal substrate materials considered suitable for coating and even building up plural layers of coating material (taught by Miller) would be compatible with patterning or repairing a finely patterned mask having a metal pattern on a glass substrate (as taught by Lewis et al.), which provides a reasonable expectation of success for additive repair of a clear deficiency defect in an opaque pattern on a finely patterned mask by using the finely controlled AFM having a liquid coated tip. This AFM having a liquid coated tip would also function as a nanoscale delivery device to allow formation of an ultra small patterned feature (tens of nm in dimension) in a cost effective, well-controlled manner (as taught by Miller). Furthermore, this AFM having a liquid coated tip would also be suitable for extremely finely controlled selective coating and/or selective etching of electrically non-conductive substrates as well as conductive substrates, including multilayer structures of diverse materials (e.g., to repair a defective mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc.), because an AFM probe tip can be used with conductive and/or non-conductive substrates. It would also have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using a SPM probe tip, such as a hollow tip AFM probe (taught by Lewis et al. and Miller) that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Park et al. or Starodubov), because: (a) sol-gel coating methods are known to produce smoother surfaces with fewer defects (e.g., for coating transparent glass material on an optical substrate, etc., as taught by Ukrainczyk); (b) it is feasible to dip sol-gel solution coating material or sol-gel catalyst (precursor) material into or on the hollow tip of an

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AFM (e.g., without clogging the hollow tip, etc.) to be used for repairing a mask (as taught by Mancevski, e.g., for additive repair of the mask, etc.); and either (c) selective printing by an AFM tip using sol-gel chemistry (coating material) for selectively coating a desired substrate (such as for repairing a high resolution mask) provides a low temperature method using a precursor to produce a wide range of compositions (e.g., glasses, metal oxides, etc.) in various forms with better purity and homogeneity than would be achieved with high temperature conventional processes (as taught by Mirkin et al. '62004) or (d) selective direct write coating by a conventional AFM tip (e.g., with a hollow tip, etc.) using a sol-gel process for coating a precursor solution onto a desired substrate (such as for repairing a mask) allows deliberate control over feature size and shape, as well as interfeature distance and location, while including the use of relatively inexpensive instrumentation, good alignment and resolution, and versatility in compositions that can be deposited under controlled conditions (as taught by Mirkin et al. '42106). This would provide a reasonable expectation of success for producing or repairing transparent PS material on a PSM by extremely finely controlled addition of sol-gel coating or precursor material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair a mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claims 1-3, 7-13, 17-23, 25, 29-34, 36-41, 44-47, 66-72, 98-101*).

Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946), either Park et al. (US 5,871,869) or Starodubov (US 5,972,542), further in view of Ukrainczyk (US 6,253,015),

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Mancevski (US 6,146,227), and either Mirkin et al. '62004 (US 2003/0162004) or Mirkin et al. '42106 (US 2004/0142106) as applied above to claims 1-3, 7-13, 17-23, 25, 29-34, 36-41, 44-47, 66-72, and 98-101, and further in view of Kley (US 6,337,479).

While teaching most aspects of the instant claim, Lewis et al., Miller, either Park et al. or Starodubov, Ukrainczyk, Mancevski, and either Mirkin et al. '62004 or Mirkin et al. '42106 do not specifically teach the use of plural tips on the AFM for repairing the mask (such as a PSM).

The teachings of Kley are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using an SPM probe, such as a hollow tip AFM probe that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Lewis et al., Miller, either Park et al. or Starodubov, Ukrainczyk, Mancevski, and either Mirkin et al. '62004 or Mirkin et al. '42106) to use plural probe tips for modifying or repairing the mask (as taught by Kley), because this would provide a reasonable expectation of success for precision control of plural additive and/or subtractive repair operations on the mask (as taught by Kley), while obtaining the benefit of reduced processing time during the mask repair. This would also provide for extremely finely controlled addition of sol-gel coating material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair transparent PS material on a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claim 35*).

Response to Arguments

Applicants' arguments on pages 13-18 of 18 with respect to claims 1-3, 7-13, 17-23, 25, 29-41, 44-47, 66-72, and 98-101 have been considered, but they are either moot or unpersuasive in view of the new ground(s) of rejection in this Office action. The current arguments only address the previous grounds of rejection, which have now been withdrawn in favor of new art rejections that are set forth above.

The deficiencies of Lewis et al. are covered by the other cited references for at least the reasons given above.

On page 15, Applicants argue that “Miller is trying to avoid anything to do with masks” and selectively cite only one of Miller’s objectives for direct nanoscale fabrication “without *using* a mask” (c1/L42-44, emphasis added). However, this argument ignores another objective of Miller for providing a method that creates “smaller mask features” (c1/L46). So, Miller does not teach away from mask repair. In fact, Miller states that any substrate known to those skilled in the art may be used (particularly substrate materials that specifically include glass and/or metal, c2/L59-61). These substrate materials are consistent with those often found in masks, such as PSMs, in need of repair.

Also on page 15, in response to Applicants' argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21

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USPQ2d 1941 (Fed. Cir. 1992). In this case, the particular reasons for combining the references in the re-written rejections set forth above are presented in the corresponding rejections.

In response to Applicants' argument on page 15 that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Applicants' disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971). Furthermore, Applicants are reminded that the subtractive and additive repair of masks (such as PSMs made of glass and/or metal) by using AFMs taught by the cited prior art references are included within the broader category for selective application of etchant and/or coating material to very small areas on a substrate of the same or similar material (e.g., glass, metal, etc.) with high precision (as found in the references discussed above) and the reasons for combining the references cited are explained above. Therefore, it is still believed that no improper hindsight has been relied upon. This is especially true, because the knowledge necessary for combining the cited references was within the level of ordinary skill in the SPM art and the mask repair art (both of which were clearly in the same field as Applicants' endeavor at the time of the instant invention).

In response to Applicants' argument on page 16 that the application of material from the coated AFM tips taught by Lewis et al. and Miller are incompatible, the test for obviousness is not whether the features of a secondary reference (Miller) may be bodily incorporated into the structure of the primary reference (Lewis et al.); nor is it that the claimed invention must be

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expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). In this case, these prior art references are in the same field of Applicants' endeavor for applying material from a SPM type probe tip (such as an AFM tip) for either repairing defects on a mask (Lewis et al.) or selectively treating areas of another substrate (Miller), in which the substrate is made from the same or similar materials as the defective mask (taught by Lewis et al. and Miller).

Likewise on pages 16-17, Applicants argue that the sol-gel deposition methods on the PSM taught by Park et al. are not compatible with the AFM subtractive and/or additive repair of masks taught by Lewis et al. and Miller (in combination). As stated above, the test for obviousness is not whether the features of a secondary reference (Park) may be bodily incorporated into the structure of the primary references (Lewis et al. and Miller); nor is it that the claimed invention must be expressly suggested in any one or all of the references. In fact, one of ordinary skill in the art would have known how to modify or adjust the material compositions and properties or even the dimensions and surface properties of the AFM tip, such as a hollow tip (as taught by Lewis et al. and Miller), to transport sol-gel coating material or sol-gel precursor to the desired selected location(s) on the substrate, such as locations of needed PS material on a PSM, without clogging the AFM tip (as taught by either Park or Starodubov in view of Ukrainczyk and Mancevski). Further evidence for the suitability of mask repair using an AFM (hollow) tip to transport sol-gel coating or precursor material to selected defect regions of the mask substrate is additionally provided by either Mirkin et al. '62004 or Mirkin et al. '42106.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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